

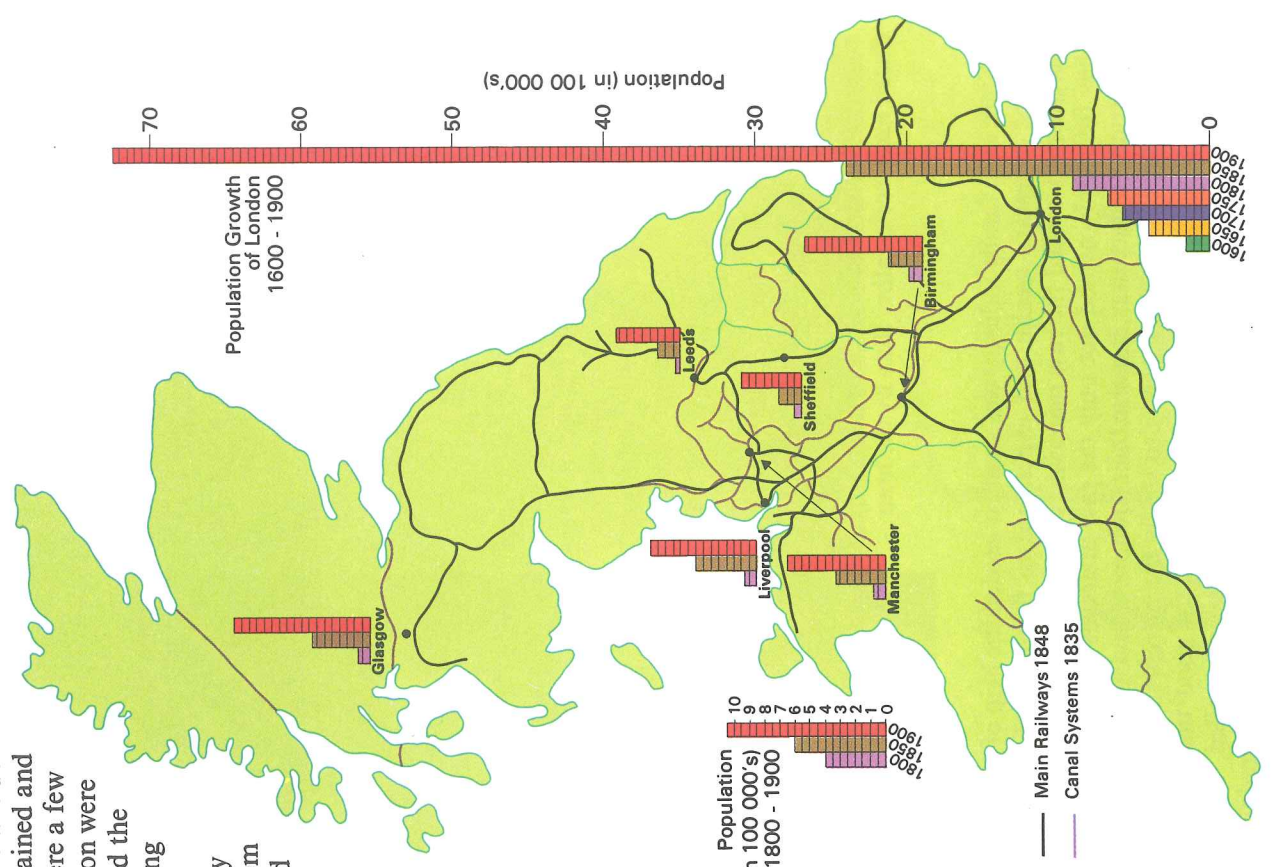
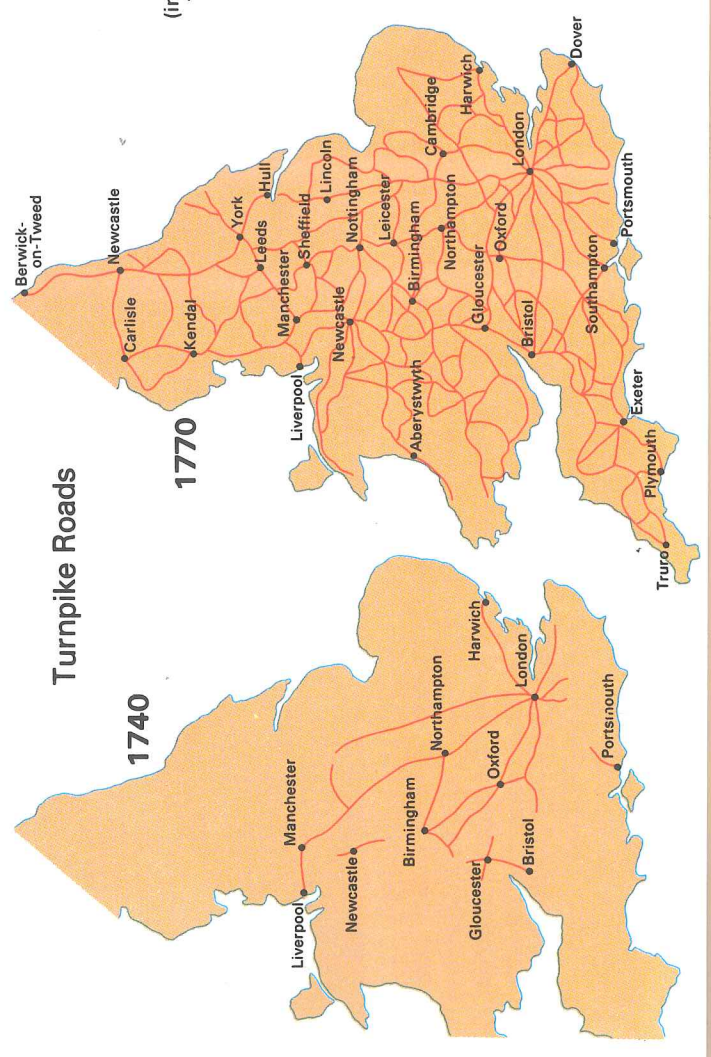
One of the key factors in the rise of the new industrial areas in Britain was the relationship between agricultural change, transport and towns. London needed most of England to maintain its food supply. Here is a partial list of its consumption in 1725:

4 686 595 kg flour	70 000 sheep	16 977 340 kg butter and cheese
60 000 calves	239 000 pigs	22 700 000 litres milk

To carry such quantities to the growing city, the existing roads had to be improved. This was done by slowly changing the roads into turnpikes. A turnpike road was one which was maintained and improved with money raised by charging tolls for its use. In 1740 the only turnpikes were a few sections of road radiating from London. By 1770 many more existed. The links to London were complete and a complex network was developing in the rest of the country. This speeded the movement of farm products, raw materials and manufactured goods between the growing provincial centres.

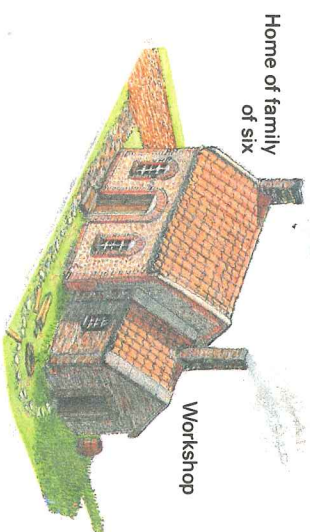
Since heavy traffic and Britain's frequent rain could make these roads impassable very quickly, turnpikes alone could not meet all the needs of the industrial areas. This problem was solved by building an extensive series of canals from the 1760's onwards. These linked the industrial regions, the agricultural areas and the seaports. The final stage of the transport revolution began with the building of the first railways in the late 1820's.

These changes in transportation meant that people as well as goods could move more freely. As a result, traditional communities, customs and patterns of life were broken up. Family relationships changed and, by the end of the eighteenth century, people in the industrial areas were getting married and raising children at a much earlier age. This change in child-rearing patterns in turn contributed significantly to the rapid growth of population.



85 Domestic Manufacturing: The Nail Shop

Before the Industrial Revolution most manufactured goods were produced in homes by families who worked together. The working place was in the home itself or in a small workshop located nearby. This was called the domestic system.



Outstanding examples of British domestic industries in the 1700's and early 1800's were the woollen textile, framework knitting, hand-loom weaving and the metalworking industries. Nailmaking shops, like the one shown in this picture, remained a domestic industry until the 1860's and the same was true of many other metalworking trades.

Nailmaking involved several steps. The iron rod had to be heated in the forge and the end hammered to form the point. The nail then had to be cut off the rod; it was then reheated and the head formed by more hammering. After the nail was shaped, it had to be quenched in cold water to temper it. This made the nail strong enough to withstand being hammered into wood. Often each member of the family old enough to work learned the entire manufacturing process. Families were paid by the piece, for what they produced each week, rather than by the hour.



Since each family industry was small, it needed the help of a merchant who had the necessary wealth and experience to finance and organize things. Merchants provided the raw materials and collected and sold the products. They frequently owned not only the raw materials and the products of the domestic manufacturers, but also their equipment and homes. Since the prices paid to domestic workers were also set by the merchants, their control over domestic workers could be almost complete. In good times the domestic workers had some freedom. A common practice was called "keeping Saint Monday," in which they took Monday (and perhaps Tuesday) off and

crammed the week's work into the next four days.

Domestic industry was widely distributed to serve the majority of the people who, until the Industrial Revolution, lived in small towns and on farms. It existed in the countryside, in close relationship with rural society. Before the building of railways and canals, the domestic system was well suited to the small communities and primitive transportation conditions of pre-industrial Britain.

During the Industrial Revolution manufactured goods began to be produced by large numbers of people working in factories.

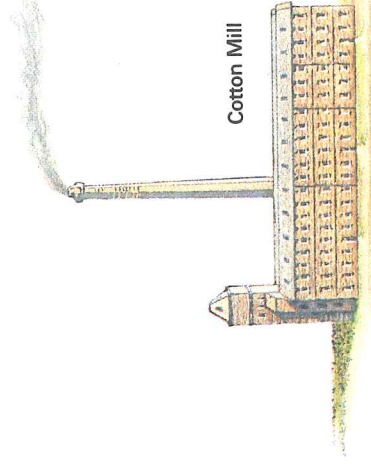
The factory system could only develop in industries where production could be divided into standard steps and where markets were large enough to support the overhead costs of the machinery, buildings and steam engines. During the first half of the nineteenth century, cotton was the only industry in which these conditions existed.

This picture shows a cotton spinning mill in the mid-nineteenth century. It is dominated by machines and the unguarded belts and drive shafts which connect them to a steam engine situated elsewhere. Mill workers attend the machines which are preparing cotton fibre for spinning. The overseer directs the work. In the background a young boy carries a box of cotton waste which he has collected by crawling under and between the running machinery.



Producing cotton thread and cloth involved a number of tasks which are illustrated on page 87. Each factory worker was trained to complete one step in the manufacturing process, usually with the help of a machine that greatly increased his or her output. Workers became specialists, repeating their tasks so often that they performed them quickly and reliably.

The repetitive work was boring, and workers became tied to machines that were often noisy, dirty and dangerous. Because these machines were expensive, work days became much longer so that the machines could be fully used and pay for themselves more quickly. Workers' lives became more regulated by the requirements of the machines and "Saint Monday" could no longer be enjoyed.



87 Transformation of the Cotton Industry

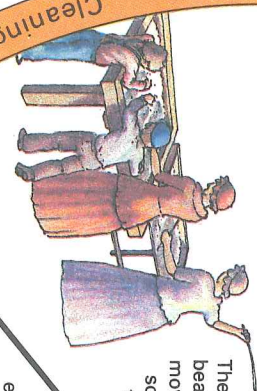
The cotton industry was well suited to mechanization: it could be divided into well-defined processes; cotton fibre was strong and consistent enough to adapt well to machine handling; demand for the product was sufficient to support the cost of factory buildings and equipment. The story of the cotton industry illustrated below helps to explain how there was an "explosion" of

inventions during the Industrial Revolution. The invention of a new machine or technique improved only one step in a manufacturing process. This often meant that the other processes were too slow or inefficient to keep up, so industrialists were forced to seek ways of improving them. In turn, this stimulated further inventions.

Eli Whitney invented the "cotton gin" in 1794. It could clean 25 kg of cotton in a single day whereas only 500 g a day could be cleaned by hand.

Cleaning

The seeds are picked out of the cotton.



The cotton is beaten to remove dirt and soften the fibres.

Carding separates and strengthens the fibres.

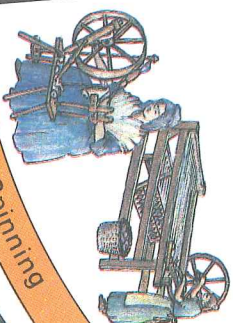
Carding

Cotton is separated into strands by hand.



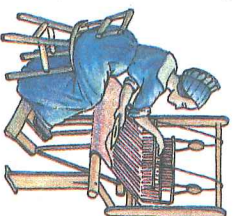
Roving

Cotton is spun into fine yarn using the spinning wheel. The "jenny" was invented in 1765 and could hold many spindles at the same time.



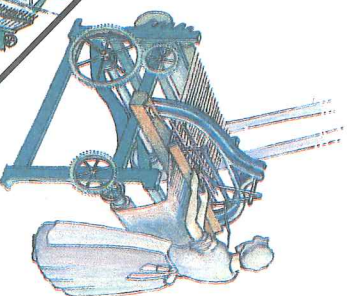
Spinning

Five spinners were required to keep up with one hand-loom weaver.

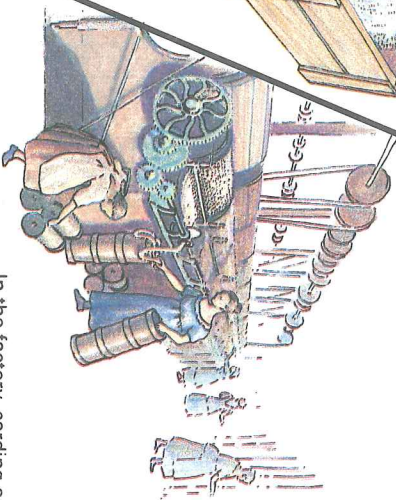
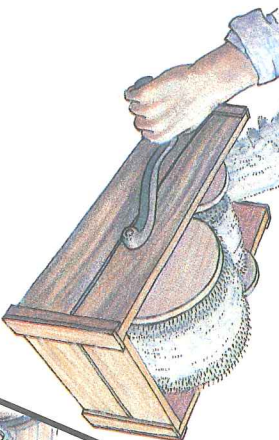


Weaving

Steam-powered looms became practical in 1806. They competed directly with hand-loom weavers, who soon found themselves out of work. Two power looms could be run by one unskilled person and could produce 3.5 times as much cloth as one hand-loom weaver.

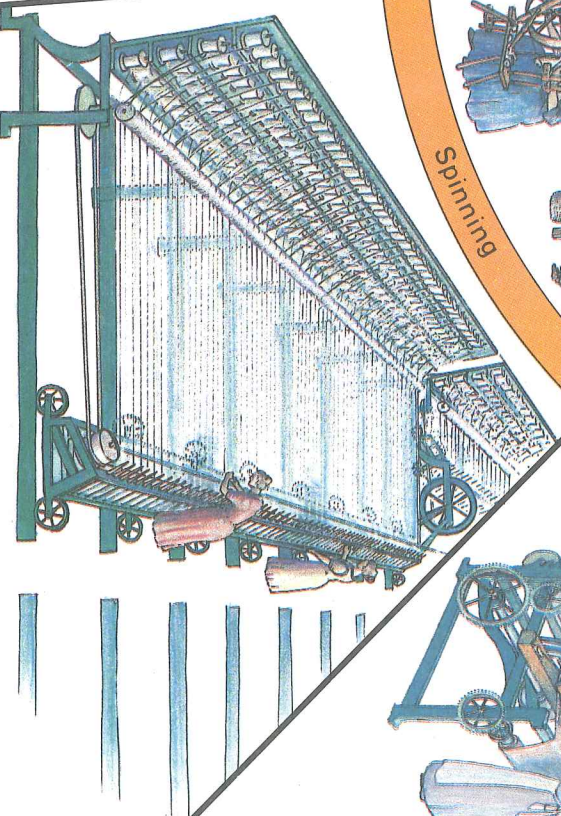


The carding machine could disentangle or comb cotton fibres many times faster than a hand carder.



In the factory, carding and roving could be done by one machine. Roving is the process whereby the loose cotton cord is given a light twist to make the fibres more compact and stronger so they can be spun by machine.

After Samuel Crompton invented the "mule" in 1779, more and more spinning was done in factories using steam-powered engines. The mule could spin very strong yarn, yet keep it as fine as the jenny could. The mule could spin 200 times faster than the spinner at a spinning wheel.



FACTORY

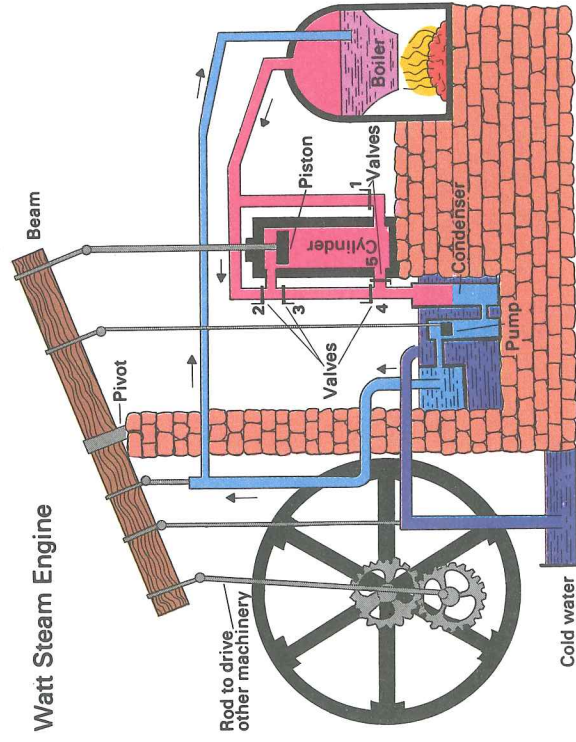
SYSTEM

Achievements in technology helped to foster the Industrial Revolution. Three were most important.

1. Steam was harnessed to provide a flexible and powerful source of energy.
2. Iron forging was mastered to create a plentiful building material with much structural strength.
3. Steam and iron were combined to develop machines of great power, efficiency and speed.

Power

The steam engine was the central innovation of the Industrial Revolution. As inventors extended its flexibility, it became the chief source of power for a widening range of industries. Two key inventions gave steam its importance:

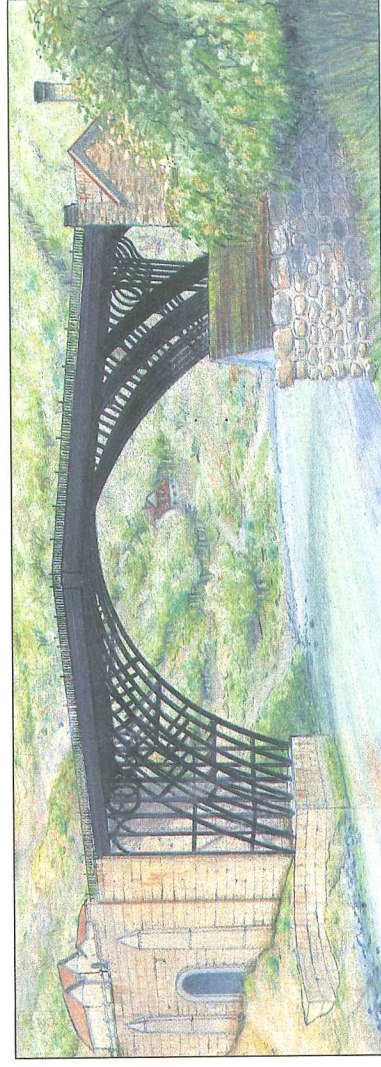


Watt Steam Engine — Between 1767 and 1790 James Watt made important improvements to existing steam engines, adding significantly to their power. He developed new engines that used low steam pressures, large cylinders and pistons, and slow speeds.

High-Pressure Steam Engine — In the early 1800's Richard Trevithick and George Stephenson were among a team of inventors who developed a high-pressure engine which used a small piston working at high speeds under high pressure. Because these high-pressure engines needed to be accurately made according to standard patterns, they forced a significant later development — precision engineering and machine toolmaking.

Structure

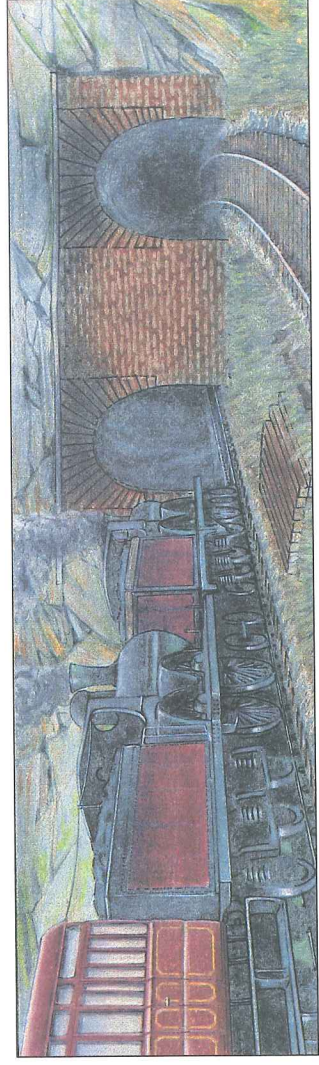
Ironmaking had long been important in England, but it was not until the last years of the eighteenth century that smelting processes improved enough to increase the availability of good-quality iron at reasonable prices. From then on, structural iron for bridges, roof trusses, railways and cannons was as vital as steam itself. However, the production of iron was still limited by its dependence on skilled manual work. In the 1860's, when the Bessemer converter was invented, a new round of inventions led to the mass production of iron at low cost. Iron was now able to reach its full potential.



Coalbrookdale Bridge — the first cast-iron bridge, built 1773-1779

Movement

If steam provided the "muscle" and iron the "skeleton" of the Industrial Revolution, then working together, they provided the movement so important to industry and transportation. Watt's engines were used mainly to drive slow machinery (pumps, flour mills). The high-pressure engines brought steam to the factories and made steam locomotives and steamships possible.



Steam Locomotive